Is the caudal auricular axial pattern flap robust? A multi-centre cohort study of 16 dogs and 12 cats (2005 to 2016)

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A multi-centre cohort study of 16 dogs and 12 cats (2005-2016)

ABSTRACT

Objective:

To determine the frequency and type of healing complications arising after the use of the caudal auricular axial pattern flap to close defects on the head in dogs and cats.

Study Design

Multi-centre retrospective cohort study

Material and Methods

Centres were recruited via the Association for Veterinary Soft Tissue Surgery (AVSTS) Research Cooperative (ARC). Medical records of 11 centres were reviewed, and data from all dogs and cats treated with a caudal auricular axial pattern flap were retrieved. The following data were recorded: signalment, reason for reconstruction, flap dimensions, anatomic landmarks used, histological diagnosis, flap healing, and whether revision surgery was required.

Results

28 cases were included: 16 dogs and 12 cats. Flap length:width ratio was approximately 3:1 and flap length extended to the scapular spine in most cases. Optimal wound healing occurred in 5/16 (31%) dogs and 6/12 (50%) cats. Wound dehiscence without flap necrosis occurred in 1/16 (6%) dogs and 1/12 (8 %) cats. Wound dehiscence with flap necrosis occurred in 10/16 (63%) dogs and 5/12 (42%) cats. Revision surgery was performed in 8/16 (50%) dogs and 3/12 (25%) cats.

Conclusion and Clinical Relevance

The caudal auricular axial pattern flap can provide full thickness skin coverage for large defects on the head in dogs and cats. Partial flap necrosis is a common complication, and revision surgery may be required in order to achieve final wound closure.

INTRODUCTION

Large skin defects in dogs and cats can be challenging to reconstruct and many reconstructive techniques have been developed that allow tension-free closure, including subdermal plexus and axial pattern flaps (Field and others (2015), (Hunt 2012, Wardlaw and Lanz 2012). Axial pattern flaps incorporate a direct cutaneous artery and vein, which improves their perfusion and viability. The main advantage of axial pattern flaps is that they are more robust and allow for greater mobilization of a longer flap with higher survival rates compared to a subdermal plexus flap (Pavletic 1981, Smith and others 1991).

Several axial pattern flaps have been described to cover large defects of the head in dogs and cats, and they include the superficial temporal, omocervical, angularis oris, and caudal auricular axial pattern flap (Fahie and Smith 1999, Losinski and others 2015, Pavletic 1981, Smith and others 1991). The caudal auricular axial pattern flap was first described by Smith and others (1991) and is based on the sternocleidomastoideus branches of the caudal auricular artery and vein originating between the lateral aspect of the wing of the atlas and the vertical ear canal. These branches course in a caudal and dorsal direction parallel to the central cervical region and supply the cranial aspect of the cervical skin, the platysma muscle, and subcutaneous fat, and eventually anastomose with the superficial cervical artery. Smith and others (1991) described the flap base as the palpable depression between the lateral aspect of the wing of the atlas and the vertical ear canal, centred on the lateral aspect of the wing of the atlas. The flap runs caudally over the central neck, between parallel dorsal and ventral lines extending from the flap base to the spine of the scapula.

There is limited published information regarding the clinical or experimental use of the caudal auricular axial pattern flap. The available literature includes two experimental studies (Smith and others 1991, Smith and others 1993), which included the clinical use of the flap in two cats, both of which had complete flap survival, and three reports of its clinical use (Field and others 2015, Spodnick and others 1996, Stiles and others 2003). In the Spodnick and others (1996) clinical series, the caudal auricular axial pattern flap was utilized in three cats and no complications or flap necrosis were reported. Stiles and others (2003) used this flap in three cats and one dog following orbital exenteration and described flap necrosis in two cats, both requiring revision surgery. In a more recent study by Field and others (2015) looking at 73 axial pattern flaps in dogs and cats, the caudal auricular axial pattern flap was used in two dogs, but no specific information was reported regarding flap survival or outcome.

The aim of this study was to determine how frequently complications arise after use of the caudal auricular axial pattern flap to close defects on the head in dogs and cats.

MATERIAL AND METHODS

This study was approved by the Association for Veterinary Soft Tissue Surgery (AVSTS) Research Cooperative (ARC) and by the Animal Health Trust (UK) Clinical Research Ethics Committee. Centres were invited to participate via ARC's list server and via direct contact with the authors.

Medical records from contributing institutions were reviewed and data were retrieved for every dog or cat treated with a caudal auricular axial pattern flap between 2005 and 2016 with at least 4 weeks follow-up. Exclusion criteria were previous irradiation of the donor or recipient site. The following data were recorded, where available: breed; sex; neutering status; age; reason for reconstruction; specific location of the defect; histological diagnosis; flap dimensions (cm width and length); anatomic landmarks used; use of surgical drain; flap healing (optimal flap healing defined as flap healing without necrosis or dehiscence; wound dehiscence without flap necrosis; wound dehiscence with flap necrosis); location (flap divided into nine zones; dorsal-middle-ventral thirds, and rostral-middle-caudal thirds, according to the harvested but unrotated flap) and extent of necrosis (cm width and length; and estimate of proportion of flap involved (<10%, 10-<25%, 25-<50%, 50-<75%, 75-100%); and revision surgery performed (yes/no).

RESULTS

Data were available for all cases unless otherwise stated.

Dogs

Data were available for 17 dogs (Table 1). One dog was excluded as the flap was used to reconstruct a non-healing wound secondary to radiation necrosis after surgical resection and irradiation of a multilobular osteochondrosarcoma. The remaining 16 dogs had caudal auricular axial pattern flap reconstruction after tumour excision. For the six dogs with specific flap dimension data available, the median (range) flap length used was 19.3cm (10.0-27.0cm). The median (range) flap width used was 6.5cm (4.5-10.0cm). For the eight dogs with specific anatomic landmark data available, 5/8 (62.5%) extended caudally to the scapular spine and 3/8 (37.5%) did not extend to the scapular spine; and 8/8 involved the central third (dorsoventrally) of the neck skin. Three (18.8%) cases included use of an active suction drain. Histological diagnosis included soft tissue sarcoma (8, of which two were low grade, four were intermediate grade, and two were of unknown grade), squamous cell carcinoma (2), mast cell tumour (3, of which two were grade II and one was unknown grade), and malignant melanoma (3). The most common location of the defect was the orbital area following exenteration (11/16 dogs) followed by defects on the frontal area (2/16), the cheek (2/16), and the ear base (1/16).

Outcome in dogs is summarised in Table 2. Optimal healing occurred in 5/16 (31.3%) dogs; dehiscence without flap necrosis occurred in 1/16 (6.3%) dogs; and wound dehiscence with flap necrosis occurred in 10/16 (62.5%) dogs. For seven dogs with data available, the median (range) length of the region of necrosis was 4.0cm (2.0cm-10.0cm) and the width of necrosis was 5.0cm (0.5cm-10.0cm). For the seven dogs with data available, the median (range) estimated proportion of flap necrosis was 10-<25% (range <10% to 75-100%). The regions of the flap that underwent necrosis were always at the distal tip (caudal-dorsal, caudal-middle, and caudal-ventral regions of the flap), and with more extensive cases of necrosis, also involved the middle-dorsal, middle-middle, and middle-ventral regions. Revision surgery was performed in 8/16 dogs (50.0%). Of the 10 dogs with wound dehiscence and flap necrosis, 7 (70.0%) underwent revision surgery. The dog that had wound dehiscence without flap necrosis also underwent revision surgery. For the seven dogs with necrosis, the following revisions were performed: debridement and local side-to-side closure (n=2), debridement and closure using either the original flap (n=1) or an extension of the original flap (n=1), debridement and closure using a combination of side-to-side closure and an extension of the original flap (n=1), and debridement and closure using a local subdermal plexus flap harvested from the ventral neck (n=2) (one of which had incomplete closure with the open wound healing by second intention).

Cats

Data were available from 12 cats (Table 1). No cases were excluded. The reason for the use of the caudal auricular axial pattern flap was reconstruction after tumour resection in all cats, with the orbital area being the most common location of the defect (10) followed by the temporal region (1) and ear base (1). For eight cats with data available, median (range) flap length was 16.0cm (7.0-18.0cm) and flap width was 5.0cm in all cases. For cases with specific anatomic landmark data available, 7/9 (77.8%) extended caudally to the scapular spine and 2/9 (22.2%) did not; all involved the central third (dorsoventrally) of the neck skin. One case (8.3%) had a passive drain placed at surgery. Histological diagnosis was soft tissue sarcoma (7, of which two were low grade, three were intermediate grade, one was high grade, and one was of unknown grade), squamous cell carcinoma (4), and mast cell tumour (1).

The outcome in cats is summarised in Table 3. There was optimal wound healing in 6/12 (50.0%) cats. Wound dehiscence with and without flap necrosis occurred in 5/12 (41.7%) and 1/12 (8.3%), respectively**.** The median (range) length of the region of necrosis was 5.0cm (4.0-8.0cm) and the width was 5.0cm in all five cats. The estimated proportion of the flap undergoing necrosis was 25-<50% in all five cats with necrosis. The regions of the flap undergoing necrosis were always the distal tip (the caudal-dorsal, caudal-middle and caudal-ventral regions) and extended to include the middle-dorsal, middle-middle, and middle-ventral regions in cases with more extensive necrosis. Revision surgery was performed in 3/12 (25.0%) cats. Of the five cats with wound dehiscence and flap necrosis, three (60.0%) had revision surgery and two (40.0%) healed by second-intention without the need for further anaesthesia or surgery. The following revision surgeries were performed: surgical debridement and primary closure of the wound (n=1), debridement and closure using advancement of the flap (n=1), and debridement and closure using a local subdermal plexus flap derived from the ventral neck skin (n=1). One cat with wound dehiscence without flap necrosis healed by second intention without revision surgery.

DISCUSSION

The main finding of this retrospective study of 16 dogs and 12 cats treated with a caudal auricular axial pattern flap was the relatively high complication rate. The most common complications were necrosis of various lengths of the distal aspect of the flap, which was reported in 62.5% of dogs and 41.7% of cats and isolated dehiscence of the flap in 6.3% of dogs and 8.3% of cats.

The mean length of survival of the caudal auricular axial pattern flap was 85% in two experimental studies (Smith and others 1991, Smith and others 1993). In these studies, the flap was created, elevated, and then sutured back in place at the donor site without rotation or transposition. In addition, the authors did not always extend the flap up to the scapular spine. However, 67% of both canine and feline caudal auricular axial pattern flaps underwent necrosis of varying degrees. Furthermore, optimal healing, namely full flap survival with no necrosis or wound dehiscence, was reported in 31.3% of dogs and 50.0% of cats in the present study. In previous experimental and clinical studies, optimal healing was reported in 33% to 100% of dogs and 33% to 75% of cats (Smith and others (1991), (1993), Spodnick and others 1996, Stiles and others 2003). These results, in combination with the findings of the study reported herein, suggest that some degree of necrosis of the caudal auricular axial pattern flap is common.

The flap dimensions used were not known for all cases in this study, but the majority of the flaps with specific data available in this study extended to the scapular spine. Although this is reported as the appropriate caudal limit of the caudal auricular axial pattern flap, it is interesting to note that the Smith and others (1991) often used shorter flaps than this. Although it is not clear which of their cases involved a shorter flap, the extra length of the flap used may have contributed to tip necrosis in this study.

It is of interest to note that in this study, the dogs with flap necrosis had a greater variety of necrosis and seemed to have a smaller proportion of necrosis (10-<25%)

than the cats with necrosis, all five of which had 25%-<50% necrosis. These data should not be seen as reliable, but could reflect anatomic differences between the species. Future studies are warranted to investigate this further.

While it is unknown why many of these flap tips had inadequate blood supply for survival and underwent necrosis, the authors speculate that various factors could have been involved, such as: tension (including that caused by seroma fluid, and by patient movement); anatomical variation of vascular anatomy; torsion of the flap pedicle; surgeon's experience or qualification; surgery time (thrombosis and/or infection); location of the tumour; co-morbidities; other unknown factors. With regards to surgeon's experience, it is important to note that all but two procedures were carried out by a boarded surgeon or a supervised resident. Both of the procedures carried out by non-boarded/non-resident surgeons healed either uneventfully or with minor wound dehiscence not requiring revision surgery. Surgery time is another known risk factor for surgical site infection (Brown and others (1997) but unfortunately this was inconsistently recorded in the medical records and could not be evaluated further.

Revision surgery was felt (by the attending surgical team) to be necessary in 8/11 (72.7%) of the dogs with healing complications and 3/6 (50.0%) of the cats with healing complications. There were four dogs and three cats in this study whose wound dehiscence was not felt to warrant revision surgery. Unfortunately, this study design does not allow for detailed understanding of the decisions involved in these cases. Revision surgery was successful in all cases, and mostly involved simply pulling the surrounding skin together (with or without pulling the remaining flap further across, or raising further flap tissue) over the defect left by the necrosis, after debridement. In three cases, revision surgery included a local subdermal plexus flap, which was derived from the ventral neck skin.

Surgical margins have not been reported in this study as specific data were not available. The decision-making process regarding individual cancer care is complex and this study was not designed to investigate it. Another alternative approach for some of these cases might have been planned marginal excision followed by radiotherapy. This could have resulted in a smaller surgical defect needing only local closure. The surgical teams at the centres involved in this study came to a decision with the owner at the time, taking into account all local factors and balancing logistics, complication risk, overall treatment costs, and prognosis. This includes cases such as Case 23, where this surgical dose was recommended as part of a multi-modal treatment plan. Specific, strong, data regarding these treatment choices for the various cancer types is sparse in the veterinary literature, and further studies are warranted.

It is important to note that in this study wound dehiscence and flap necrosis did not always require revision surgery, and that all patients healed eventually with one revision surgery. This is consistent with 2 large retrospective studies by Field and others (2015) and Trevor and others (1992) that reported high complication rates but also a high overall success rate. The findings of this study are supportive of these two studies and they reinforce that axial pattern flaps in general and caudal auricular axial pattern flaps specifically may not be as robust and revision surgery should be expected and this should be communicated with the owner.

This delay in healing could also delay adjuvant treatment if this were indicated, however subsequent review of case data made during the review process for this manuscript showed 0/28 cases underwent adjuvant treatment with chemo- or radio-therapy and 1 case with oral malignant melanoma received adjuvant immunotherapy which was not delayed by the wound healing complications, as expected by the protocol of Piras and others (2017) followed at this centre. The reason for the lack of adjuvant treatment was either that it was not indicated, or that the owner declined it.

Limitations of this study include those inherent to retrospective studies. Perioperative management and the management of flap-related complications were not standardized. The original flap limits and dimensions were infrequently included in the medical records. The degree of flap necrosis (when present) was also infrequently recorded. However, despite these limitations, this study is currently the largest collection of data regarding the clinical use of the caudal auricular axial pattern flap in dogs and cats, and found that this flap can provide full thickness skin coverage for various large skin defects of the head in dogs and cats. Surgeons, and owners, should be aware that flap necrosis should not be seen as an unexpected complication when this flap is used in clinical cases and revision surgery may well be required in order to achieve final wound closure.

CONFLICT OF INTEREST

There are no grants, financial support or conflicts of interest to declare

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	breed	age (in years)	sex and neutering status	Location of the defect	Cause of defect (ex trauma or neoplasia)	histological diagnosis
1	Labrador Retriever	6.5	MN	left orbital area	neoplasia	intermediate grade soft tissue sarcoma
2	Boxer	10	MN	Dorsal head, temporal region and nuchal crest	neoplasia	intermediate grade mast cell tumor
3	crossbreed	7	MN	left orbital area	neoplasia	undifferentated spindle cell sarcoma, neurofibrosarcoma
4	crossbreed	6	MN	left orbital area	neoplasia	low grade soft tissue sarcoma
5	Yorkshire Terrier	12	FN	Right cheek	neoplasia	aggressive malignant melanoma
6	Labrador Retriever	5	M	left orbital area	neoplasia	intermediate mast cell tumor
7	German Shepherd	9	FN	left cheeck	neoplasia	Melanoma
8	crossbreed	9	MN	right frontal area	neoplasia	Squamous cell carcinoma

9	Labrador Retriever	9	FN	left orbital area	neoplasia	soft tissue sarcoma unknown grade
10	Golden Retriever	5	FN	left orbital area	neoplasia	soft tissue sarcoma intermediate grade
11	Labrador Retriever	6	MN	left orbital area	neoplasia	soft tissue sarcoma low grade
12	Cocker Spaniel	1.5	FN	right orbital area	neoplasia	intermediate grade fibrosarcoma
13	Australian Cattle Dog	10	M	Base of right ear	neoplasia	intermediate grade mast cell tumour
14	Crossbreed	6 years	MN	Right orbital area	Neoplasia	Soft tissue sarcoma
15	crossbreed	5	FN	right orbital area	neoplasia	malignant melanoma
16	crossbreed	14	MN	left orbital area	neoplasia	Squamous cell carcinoma
17	domestic short hair	8	FN	defect involving left orbit and left	neoplasia	low grade fibrosarcoma

				temporal region		
18	domestic short hair	4	FN	left orbital area	neoplasia	Soft tissue sarcoma grade II
19	european short hair	7	FN	left Supraorbital/orbit, frontal area	neoplasia	Soft tissue sarcoma, grade II
20	european short hair	8	FN	left orbital area	neoplasia	Squamous cell carcinoma
21	european short hair	8	FN	right orbital after enuleation	neoplasia	recurrence of a grade II soft tissue sarcoma
22	european short hair	10	FN	right temporal region	neoplasia	Mast cell tumour
23	european short hair	15	MN	Region of the ear	neoplasia	Recurrent Grade III fibrosarcoma with lymph node metastasis
24	european short hair	15	FN	right orbital area after exenteration	neoplasia	Squamous cell carcinoma
25	european short hair	9	FN	left orbital area	neoplasia	Squamous cell carcinoma
26	domestic short hair	8	FN	right orbital area	neoplasia	low grade sot tissue sarcoma
27	Domestic Shorthair	8	FN	left orbital area	neoplasia	Spindle Cell Sarcoma

28	Domestic Shorthair	11.5	FS	Right orbit	neoplasia	Squamous cell carcinoma	

Table 1. Signalment, reason for reconstruction, histological diagnosis, location of defect of all patients.

	No wound breakdown	Wound breakdown no necrosis	Wound breakdown with necrosis	Total
No revision surgery	5	0	3	8
Revision surgery	0	1	7	8
Total	5	1	10	16

Table 2: Showing flap outcome and revision surgery in dogs

	No wound breakdown	Wound breakdown no necrosis	Wound breakdown with necrosis	Total
No revision surgery	6	1	2	9
Revision surgery	0	0	3	3
Total	6	1	5	12

Table 3: Showing flap outcome and revision surgery in cats